Chapter 13
Regulatory and Design Standards for Reducing Losses

Chapter Overview
Standards provide a means for uniform application and review of practices – such as design, construction and regulation. This chapter provides a summary of adopted standards employed in utilizing various approaches to flood loss reduction and resource protection.

Introduction
Two types of standards are generally employed: design criteria and performance standards.

A design criteria or specified standard dictates that a provision, practice, requirement or limit be met, e.g., use of 1% flood, establish floodway boundaries so as not to cause more than a one foot increase in flood stages, degree of protection for a structural project.

A performance standard dictates that a goal is to be achieved, leaving it to the individual application as to how to achieve the goal. Examples are: provide protection to the regulatory flood, stormwater runoff after development is not to be more than that before development, maintain the present quantity and quality of water in a wetland.

Nationwide standards typically are established by federal agencies as part of program regulations, or sometimes directed by Congress in the language of federal legislation. The standard may be mandatory, or required only as part of participation in a voluntary program such as the National Flood Insurance Program. Federal agencies commonly establish some minimum standard with which state or local governments must comply. Generally they are free to impose a more stringent standard within their jurisdiction, but may not adopt a less stringent one.

Flood Loss Reduction Standards

Design Standards
One Percent Annual Chance Flood
Today, the one percent annual chance flood and floodplain have been adopted as a common design and regulatory standard in the United States. The National Flood Insurance Program (NFIP) adopted it in the early 1970s, after consultation and recommendations from a panel of experts, as a compromise between excessive flood losses from adoption of a lesser standard and an excessive degree of flood protection (in terms of costs and restrictions) from adoption of a higher standard. The one percent annual chance flood was formally adopted as a standard for use by all federal agencies with the issuance of Executive Order 11988 – Floodplain Management in 1977. A number of states have mandated that communities adopt the one percent annual chance flood as the minimum standard for floodplain management purposes. They are free to impose a more stringent standard within their jurisdiction.

0.2 Percent Annual Chance Flood

The U.S. Water Resources Council *Floodplain Management Guidelines For Implementing E.O 11988*, published in 1978, call for federal agencies to apply a 500-year (0.2 percent) flood standard to the location of "critical activities." Critical activities may include health care facilities such as hospitals and nursing homes, emergency services, and storage of hazardous materials. The City of Knoxville and Knox County, Tennessee, utilize this standard in their floodplain management programs.

Design Floods

A very large (low frequency) design flood may be appropriate for major structures intended to protect an area from flooding (e.g., dams, levees, floodwalls) where failure would potentially result in massive damage and/or great loss of life. The U.S. Army Corps of Engineers refer to these design floods as a Standard Project Flood (SPF) or Probable Maximum Flood (PMF). The SPF represents the most severe combination of meteorological and hydrological conditions considered "reasonably characteristic" of a particular region, while the PMF is "The flood magnitude that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible… in a region" (U.S. Army Corps of Engineers). The Tennessee Valley Authority employs use of the Maximum Probable Flood. None are equivalent to a specific return flood frequency but represent a recurrence interval in the range of thousands of years.

Regulatory Floodway

The "regulatory floodway" concept evolved to address the needs of flood-prone communities and to guide the location of future floodplain development. It is based on the principle that the area chosen for the regulatory floodway must be designed to carry the waters of a particular magnitude flood without increasing the water surface elevation more than a designated level. The assumption is made that the area of the remaining regulatory floodplain (flood fringe) will eventually be fully developed, thereby obstructing floodwaters and restricting them to the floodway.

In areas where sufficient data have been developed, communities participating in the NFIP are required to adopt a regulatory floodway. NFIP minimum regulations require that the regulatory floodway be delineated so that it can pass the one percent annual chance flood without increasing the water surface elevation within the regulatory floodway more than one foot at any point. Floodway boundaries are determined by hydraulic modeling. The model is developed to reflect current conditions, and is manipulated to establish floodplain encroachment lines on both sides of the watercourse so that the water surface within the floodway rises a foot or less. Generally, flood conveyance is removed equally from both edges of the floodplain, but exceptions are permitted. (See Chapter 5 for a discussion of the regulatory floodway.)

NFIP minimum regulations prohibit further encroachments (e.g., fill, new construction, substantial improvements, and other development) within the adopted regulatory floodway that would result in any increase in flood levels within the community during a one percent chance flood, because that floodway has already allowed a one-foot rise. Some states have adopted more stringent standards through absolute prohibition of certain new structures in the floodway. Others require that a

floodway be delineated that causes no increase in water surface elevations of the 1 percent annual chance flood. Still others limit that increase to amounts less than 1 foot, such as 0.5 feet. In the absence of state standards, a number of communities have adopted more restrictive floodway standards than those required by the NFIP. These more restrictive standards generally result in a wider, larger floodway to accommodate flood flows.

In floodplains where a regulatory floodway has not been designated, NFIP minimum regulations require that no development be permitted within the one percent annual chance floodplain that would – individually or cumulatively with other anticipated development – increase the water surface elevation of the base flood more than one foot. Again, states and communities may have more restrictive standards.

Coastal Flood Elevations

In coastal areas, wave action effects associated with storm surges are incorporated with stillwater elevations (effects of astronomical tides and storm surge) to establish the Base Flood elevation. NFIP regulations establish a V-zone (velocity zone) to indicate areas that are subject to the effects of high velocity waters and damaging wave action. The extent of the V-zone is based on how far inland from the shoreline the storm surge can support a three-foot wave. Where wave height decreases below three feet, the V-zone terminates and the remaining flood hazard area is designated an A-zone. This standard was adopted as a threshold of structural damage to buildings caused by wave action (See Figure 6-18).

Protection of Structures

NFIP criteria distinguish between residential and non-residential structures. For residential structures, new construction and substantial improvements (more that 50 percent of the present value of the structure) within the one percent annual chance floodplain must have the lowest floor, including basement, elevated to or above the one percent annual chance flood level. Non-residential structures are allowed the option of elevating the lowest floor, including basement, to be at or above the one percent annual chance flood level, or "together with attendant utility and sanitary facilities, be designed so that below the base flood level the structure is watertight with walls substantially impermeable to the passage of water and with structural components having the capability of resisting hydrostatic and hydrodynamic loads and the effects of buoyancy" (NFIP). Figures 10-1 and 10-2 further illustrate what is meant by "lowest floor."

Spaces exclusively used for parking of vehicles (i.e., garage), limited storage, or building access (i.e., stairs, elevator shafts, etc.) may be located below the base flood elevation. No machinery or equipment which service a building such as furnaces, air conditioners, hot water heaters, washers, dryers, electrical boxes, and food freezers are permitted below the base flood elevation. All interior wall, floor, and ceiling materials located below the base flood elevation must be unfinished and resistant to water damage. For fully enclosed areas, balance of internal and external water pressure is to be controlled by the size and placement of openings in the walls.

A number of states and hundreds of communities have more stringent standards than those imposed by the NFIP. The most common higher standard is to require some or all structures to

have the lowest floor, including basement, elevated a minimum of one foot above the one percent annual chance flood. Other jurisdictions require even greater elevation. These higher standards may apply to all buildings in the floodplain or only to certain types of buildings such as jails, hospitals, nursing homes, mobile home parks and hazardous materials facilities. Some coastal communities in Florida require freeboards ranging from 4 to 8 feet.

"Substantial Improvement" and "Substantial Damage"

Substantial improvement of a structure and substantial damage to a structure relate to the amount of improvements that may be made or the amount of damage that may be sustained before certain floodplain regulations and flood insurance requirements go into effect. NFIP regulations define substantial improvement as any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceed 50 percent of the market value of the structure before the start of construction of the improvement. As defined by NFIP regulations, a building is considered to be substantially damaged when damage of any origin is sustained by a structure whereby the cost of restoring the structure to its "before damaged" condition would equal or exceed 50 percent of the market value of the structure before the damage occurred.

Substantial improvements and repairs of substantial damage must meet local floodplain management regulations. These regulations require that such improvements and repairs must be protected against occurrence of the one percent annual chance flood through elevation or other measures. Flood insurance rates would also change. Figures 13-1 and 13-2 (FEMA) illustrate some of the substantial improvement provisions.

Standards Applicable to Flood Protection Structures

There are no nationwide standards applicable to all dam and reservoir construction. Each federal agency with responsibilities for construction, maintenance and inspection of dams has developed its own set of criteria, generally addressing both flood and earthquake criteria. Agencies that construct most federally funded levees have developed their own policies for levee construction and maintenance. They basically conform to standards adopted by the U.S. Army Corps of Engineers, which include a design height equal to a specified design flood level with additional freeboard as a safety factor. Required minimum freeboard is generally three feet. Many agricultural levees, often constructed without federal funding, may be designed for 5-25 year flood frequencies.

For non-federally funded levees, NFIP regulations treat mapped areas as being protected to the one percent annual chance flood if the levee system provides this level of protection. Riverine levees must provide a minimum freeboard of three feet above the water surface level of the one percent annual chance flood.

Performance Standards

Perhaps the most widely applicable performance standards relate to floodproofing of structures.

In riverine areas, NFIP requirements for construction of non-residential structures specify that a structure be elevated to or above the one percent annual chance flood or be designed to resist flood

damage. This requirement provides an option of meeting a specific standard (elevation) or a performance standard (resistance to effects of flooding). Rather than specifying particular designs and materials, the regulations allow flexibility in selecting ways of achieving resistance to the effects of flooding.

In coastal areas, structures located in V-zones must be elevated on pilings and columns so that the bottom of the lowest horizontal member of the lowest floor is elevated to or above the base flood level and all structural components be anchored to resist flotation, collapse and lateral movement due to the effects of wind and water loads acting simultaneously on all components. Wind and water loading values are to each have a one percent chance of being equaled or exceeded in any given year.

Model Codes and Standards

Model codes and standards have been developed by consensus over a period of years under the auspices of the organizations that promulgate the written documents. They are designed for use by states and local governments in establishing appropriate building design and construction standards.

There are three national model codes:

1. BOCA National Building Code, which is a product of the Building Officials and Code Administrators International (BOCA), and is generally adopted by eastern and midwestern states;
2. Standard Building Code, which is a product of the Southern Building Code Congress International (SBCCI), and is generally adopted by southern states, and
3. Uniform Building Code, which is a product of the International Conference of Building Officials (ICBO), and is generally adopted by western states.

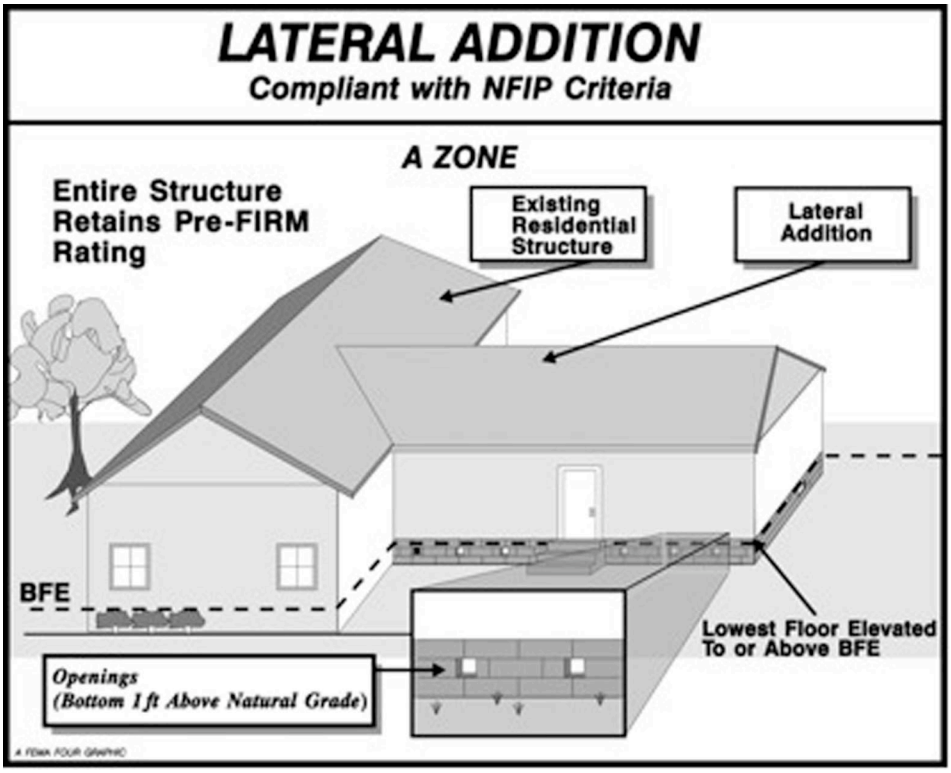

Figure 13-1. Drawing showing lateral addition compliant with NFIP criteria.

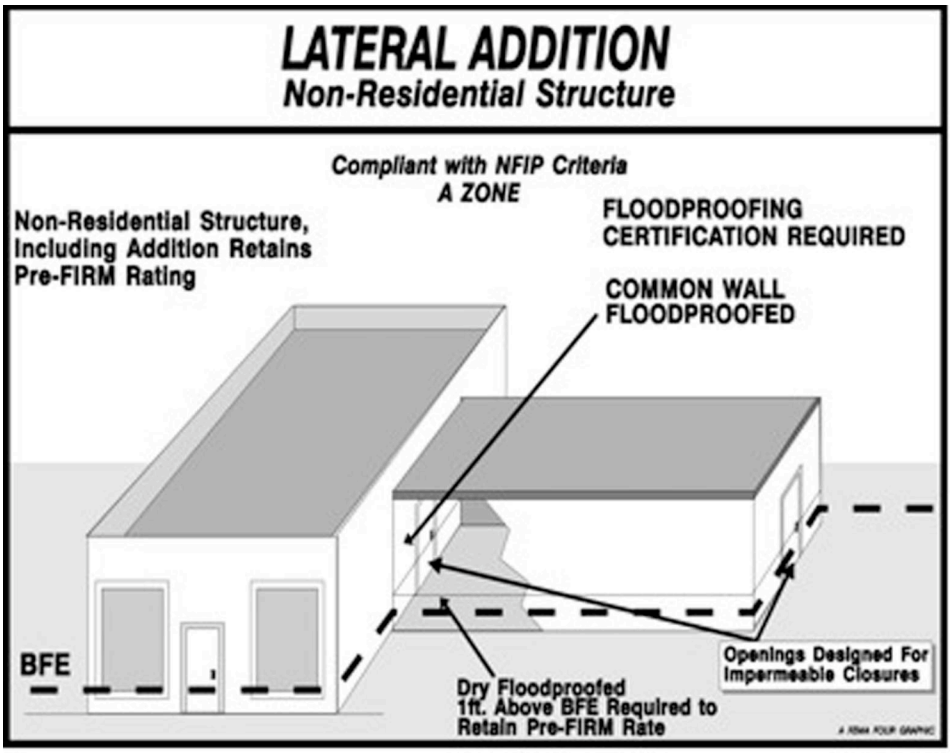

Figure 13-2. Drawing showing lateral addition of a non-residential structure compliant with NFIP criteria.

In addition, there is a fourth model building code known as the CABO (Council of American Building Officials) One and Two Family Dwelling Code. This model code is used in various parts of the country for residential structures.

These documents follow standardized formats for content and references. Within the family of national codes (i.e., National, Standard, and Uniform) the documents reference one another without duplicating information.

In 2000, the American Society of Civil Engineers assisted the NFIP in incorporating its flood damage resistant design and construction standards into the nation's model building codes, which are then adopted by either states or local communities.[1] With the NFIP design and construction requirements in the building codes, they have become more accessible, more credible, and easier to use and enforce by the building community.

Protection of Natural Resources

Prescriptive and performance standards for protection of natural resources are implicitly included in numerous federal and state legislative acts and executive orders. However, few, if any, of the standards for natural resource protection are applied specifically to floodplains. Instead, they typically apply to the particular resource of concern, wherever that resource may be found – either in or out of a floodplain. Wetland classification and delineation techniques, described in Chapter 8, have greatly aided in the identification and mapping of the nation's wetlands. This, in turn, has resulted in their improved management and protection under the auspices of various federal and state programs. The same is true in the designation of threatened and endangered species and of historic properties, coastal barriers, and wild and scenic rivers.

The only nationwide standard specifically directed at protecting floodplain natural resources is a NFIP requirement prohibiting "man-made alteration of sand dunes and mangrove stands with … V-zones … which would increase potential flood damage." Nevertheless, there are protective provisions in various legislation and executive orders described in Chapter Eleven.

The National Environmental Policy Act states that "it is the continuing responsibility of the Federal Government to use all practicable means …. to attain the widest beneficial use of the environment without degradation, risk to health or safety; preserve important historic, cultural and natural aspects of our national heritage; ..and, enhance the quality of renewable resources"

Section 401 of the Clean Water Act requires certification from the state or interstate water control agencies that a proposed project is in compliance with established effluent limitations and water quality standards.

Under the Coastal Zone Management Act, federal grants are awarded to states to assist in developing and administering management programs for land and water use within the coastal

[1] "Reducing Flood Losses Through the International Code Series," available at FEMA's website: www.fema.gov. In "Advanced Search," type the name of the publication.

zone, giving full consideration to ecological, cultural, historic and esthetic values as well as the need for economic development. State management plans are to provide for the protection of natural resources, including wetlands, floodplains, estuaries, beaches, barrier islands, coral reefs, and fish and wildlife and their habitat, within the coastal zone. The 1980 amendments provided for development of special area management plans (SAMPs) for areas of the coastal zone considered of particular importance. SAMPs are comprehensive plans that provide for natural resource protection and reasonable coastal-dependent economic growth containing a detailed and comprehensive statement of policies, along with standards and criteria to guide public and private uses of lands and waters.

The Endangered Species Act states that federal departments and agencies are to ensure that any actions that they authorize, fund, or carry out do not jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species. Section 9 of the Act identifies prohibited acts related to endangered species and prohibits all persons, including all federal, state and local governments, from taking listed species of fish and wildlife. The term "take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct. The Act also provides for civil penalties, criminal violations, enforcement, and citizen suits.

Section 106 of the National Historic Preservation Act directs federal agencies, with direct or indirect jurisdiction over proposed federal or federally assisted undertakings, to take into account effects on historic properties. Reviews are to be carried out in accordance with regulations issued by the Advisory Council on Historic Preservation, and in consultation with the Council and the State Historic Preservation Officer.

Within the Coastal Barrier Resources System no new federal expenditures or financial assistance are allowed for areas within the system. (Specific exempted projects include dredging, federal navigation projects, and some habitat management and enhancement efforts.) One of the purposes of the Coastal Barrier Resources Act, that established the System, was to minimize damage to fish, wildlife and other natural resources associated with development of coastal barriers.

The Wild and Scenic Rivers Act establishes the policy that certain rivers of the nation, with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values, shall be preserved in free-flowing condition. They and their immediate environments shall be protected for the benefit and enjoyment of present and future generations.

Executive Order 11988 – Floodplain Management is based in part on the National Environmental Policy Act of 1969, and adds new prominence to the environmental aspects of floodplain management. To achieve this, the Order requires that decision-making by federal agencies clearly recognize that floodplains have unique and significant public values. Consideration must be given, therefore, to natural and beneficial floodplain functions and resources and to the public benefit to be derived from their restoration or preservation.

Executive Order 11990 – Protection of Wetlands was issued concurrently with Executive Order 11988. The Order recognizes that the nation's coastal and inland wetlands are vital natural resources of critical importance to its citizens. The statement by the President accompanying the Order says "Wetlands are areas of great natural productivity, hydrological utility, and environmental diversity, providing natural flood control, improved water quality, recharge of aquifers, flow stabilization of streams and rivers, and habitat for fish and wildlife resources. Wetlands contribute to the production of agricultural products and timber, and provide recreational, scientific, and aesthetic resources of national interest. The unwise use and development of wetlands will destroy many of their special qualities and important natural functions. The problem of loss of wetlands arises mainly from unwise land use practices. The Federal government can be responsible for or can influence these practices in the construction of projects, in the management of its own properties, and in the provisions of financial or technical assistance." The Order was issued to avoid to the extent possible the long- and short-term adverse impacts associated with the destruction or modification of wetlands, and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative.

Chapter Homework Assignment

If you were providing professional services to a community, involving a project within a designated flood-hazard area, would you prefer that the community employs design criteria or performance standards? Provide a defense for your preference.